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Health burden of road traffic accidents, an analysis of clinical data on disability and mortality exposure rates in Flanders and Brussels

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ABSTRACT

Statistics on road traffic accidents (RTAs) mainly come from police records. The police reported RTA statistics however are known to have a large degree of under-registration, underestimating the true risk of being injured in traffic accidents. The use of medical based datasets can provide a more accurate estimate of the actual traffic accident health risk. Exposure-based rates of the actual burden from Flanders and Brussels were calculated, comparing differences between road user, age, gender and type of injury sustained. Minimal Clinical Data (MCD) was selected for the years 2003–2007, as well as data from the mortality statistics. Disability Adjusted Life Years (DALY) were calculated and put into perspective with the passenger kilometres travelled.

Motorcyclists followed by bicyclists and pedestrians showed a higher DALY per travelled kilometre (6365, 1724 and 1359 DALY per billion kilometres respectively), compared to 113 DALY per billion kilometres for motor vehicles. In bicyclists and to lesser extent in motorcyclists, the majority of the health burden was attributed to disability following injuries and not fatalities. Also in the other road user categories disability added substantially to the total health loss. The use of medical data and more particular the MCD may be a valuable addition of those RTAs that are missed by the police scope. Although the results are still conservative estimations, an injury-based approach can help to better understand the health problem that road traffic accidents cause.

1. Introduction

Road traffic injuries are a major health problem. Every year more than 1.2 million people are killed, and many million more are injured or disabled worldwide due to road traffic accidents (RTAs) (Peden et al., 2004). In Belgium, road traffic fatalities represent approximately one-third of all unnatural deaths below the age of 40 (ADSEI, 2008), which is above the European Union population average (European Road Safety Observatory, 2011). Numbers of people injured in RTAs are much harder to find. Most numbers are derived from police data. However, not all RTA victims are reported in police data. An accurate estimation of the true risk of being injured in road traffic is therefore unlikely and police data shall be an underestimate (Constant and Lagarde, 2010; Kormer and Smolka, 2009). The lack of accurate exposure estimates (e.g. kilometres travelled) adds to the uncertainties of estimating the true risk. More reliable data is needed for analysing the burden of RTAs and the injuries or casualties arising from them. Medical data is recently used to quantify the health burden of RTAs. These analyses usually indicate higher incidence rates (Chini et al., 2010).

In this study we explored an injury-based approach to more accurately estimate the health risk of RTAs using hospital discharge data (HDD) and mortality statistics. Both are population-based and constitute the most extensive data sources available. Exposure-based rates of the road traffic health burden are calculated by using Disability Adjusted Life Years (DALY), which is a useful health indicator for RTAs (Polinder et al., 2007a; Holtslag et al., 2008; Lapostolle et al., 2009; Chong et al., 2010). Hospital data (Minimal Clinical Data – MCD) and the mortality statistics from Flanders and Brussels, where it was previously not possible to use medical data for road traffic safety research, were combined with empirical data on injury consequences, giving a more complete view of the lasting health burden of RTAs. Exposure-based rates (per passenger kilometre) of the road traffic health burden that resulted in death

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or hospital in-patient treatment over the period 2003–2007 are compared in relation to other road users, age, gender and injuries sustained.

2. Materials and methods

2.1. Data selection

Injury data was obtained from nationwide MCD, governed by the Federal Public Service of Health. Selection was restricted to inhabitants of Flanders and Brussels for the ICD-9-CM (ICD-9-Clinical Modification) transport-related external causes E810–816, E818–819, E826–827 and E829 (RTA with at least one moving vehicle) and the years 2003–2007. External causes (E-codes) were aggregated into 14 groups according to the 4th digit of ICD9 E-coding, which identifies the type of injured person. To minimize double counting all transfers, day-patients and re-admissions were excluded (Langley et al., 2002; Lawrence et al., 2007).

Injury information was gathered from the main diagnosis. The injury diagnosis was translated into the EUROCOST injury classification (Polinder et al., 2004, 2005), which has been used in other recent burden of injury studies (Lyons, 2008; Haagsma et al., 2009). The 39 EUROCOST injury groups allowed to aggregate the original ICD-9-CM codes into fewer groups with a higher number of patients and offer a clear link with disability (Haagsma et al., 2009).

Four main road user groups were identified: motor vehicle (with four or more wheels), motorcycle (two or three wheels), pedal cycle and pedestrian. A rest-category 'other' was created, which included other specified and unspecified road users falling outside the four main groups. Next, a distinction between single RTAs and accidents in which several road users were involved was made, based on the ICD-9-CM codebook description of 'collision'. For 'motor vehicle' accidents (E810–816, E818–819) codes in which the description clearly states that there is a collision between two or more road-users were coded as 'collision'. A motor vehicle in collision with an object was classified as non-collision. Unspecified accident circumstances were categorized as 'unspecified'. Pedestrians were always classified as involved in a collision, unless where 'unspecified' was indicated, as pedestrians' falls were excluded from the original external cause selection. E826.1 (pedal cycle accident, bicyclist is victim) was kept as a separate category within the 'other road vehicle' accidents (E826–827, E829).

Mortality statistics were obtained from the regional authorities [Flemish Agency for Care and Health and the Brussels-Capital Health and Social Observatory (unpublished data)]. Road traffic-related mortality numbers were collected according to the same criteria as the hospital data. In Belgium people dying within 30 days following an RTA are counted as road traffic fatalities. In the hospital data all patients who died in hospital within 30 days were therefore excluded to prevent double counting with the mortality statistics. The mortality statistics classify the causes of death using the international classification ICD-10. We used the external ICD-10 causes that matched the used ICD-9-CM E-codes, i.e. V01–V89 (land transport accidents).

2.2. DALY calculation

To calculate DALY for a particular cause of disease or injury in a population Years of Life Lost (YLL) are added to the Years Lived with Disability (YLD). In our study, YLL due to mortality from RTAs were calculated by multiplying number of deaths in an age and gender class with the respective life expectancy for that age and gender class. Life expectancy was obtained from the Belgian standard life tables for the year 2005. For YLD, a distinction was made between lifelong and temporary disability. The YLD calculation was based on the disability information determined by a literature review on the associations between hospital data characteristics of injury patients and functional consequences at longer term (Haagsma et al., 2009). From the review, it was recommended using proportions of residual disability and disability weights derived from the Dutch follow-up study by Polinder et al. (2007b), since these disability weights are based on EQ-5D data of a large number of injury patients. By using the Dutch disability information we assume that the disability risk after an injury between the two neighbouring countries is comparable. For spinal cord injury and injury of nerves of arm/hand disability weights from the Global Burden of Disease were used, as these could not be provided by Haagsma et al. (2009). For temporary disability, the injury count was multiplied with a one-year disability weight for temporary consequences. For lifelong disability the number of injuries was multiplied with the residual life expectancy and the lifelong disability weight (Haagsma et al., 2009). No age weighting or time discounting was applied.

The rates of YLD (per 10,000 inhabitants) were calculated by dividing the annual average number of YLD according to gender and age by the population of 2005 (i.e. the middle of the period in question 2003–2007) and multiplying by 10,000. The rates of YLL and DALY were calculated in the same way.

The exposure-based DALY rates were based on the exposure data taken from the third Flemish travel behaviour investigation (Moons, 2009), which was conducted in the period 2007–2008, and thus overlaps with the timeframe of the MCD. The exposure data was available as the average amount of kilometres travelled per person per day for both gender and age. To estimate the total amount of kilometres, the exposure kilometres were multiplied with the respective populations and the numbers of days in 2005. Rates of DALY per billion (10^9) kilometres travelled were calculated by dividing the annual average number of DALY according to gender and age, by the total amount of kilometres travelled by age and gender.

2.3. Statistical analysis

Frequency distributions between age group (0–14, 15–34, 35–64, >64) and injury class and between injury class and collision type was calculated using the Chi^2 test. When comparing injury distributions of hospitalized patients over road user category and collision types, patients with no injury after examination were excluded from the selection. For statistical and clarity reasons the original injury classification was aggregated into six body regions which enabled to set up a contingency table to calculate the Chi^2 test. Statistical analyses were performed using SPSS version 19 (IBM, Somers, NY).

3. Results

3.1. Statistics of hospitalized patients

A total of 48,374 reported road traffic injured people were identified to be hospitalized over the period 2003–2007. In absolute numbers, bicyclists were most hospitalized, followed by motor vehicle accidents and 'other' road users. Overall the number of hospitalizations was twice as high in males compared to females. Motorcycle accidents were the most frequent in males, while females had a higher proportion of pedal cycle and pedestrian accidents. The number of in-patients for motor vehicle accidents was equal for both genders (Table 1). The distribution of both gender ($p < 0.001$) and age ($p < 0.001$) differs between road user and collision types, with the age group 15–35 having the highest number of inpatients in the motorized vehicles. In bicyclist and pedestrian,

Table 1
Frequency of hospitalizations across road user and collision/non-collision (italic are proportions, bold are proportions between road users, non-bold are proportions within a road user category).

	Males										Females									
	0–14		15–34		35–64		>64		Total		0–14		15–34		35–64		>64		Total	
	N	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
Motor vehicle	**315**	***10.11***	**3954**	***31.08***	**2932**	***23.10***	**609**	***14.57***	**7810**	***23.88***	**234**	***14.66***	**1603**	***34.07***	**1340**	***25.21***	**537**	***13.27***	**3714**	***23.71***
Motor vehicle (collision)	124	*39.37*	1232	*31.16*	1015	*34.62*	288	*47.29*	2659	*34.05*	96	*41.03*	694	*43.29*	616	*45.97*	264	*49.16*	1670	*44.96*
Motor vehicle (non collision)	43	*13.65*	1296	*32.78*	902	*30.76*	120	*19.70*	2361	*30.23*	21	*8.97*	381	*23.77*	243	*18.13*	90	*16.76*	735	*19.79*
Motor vehicle (unspecified)	148	*46.98*	1426	*36.06*	1015	*34.62*	201	*33.00*	2790	*35.72*	117	*50.00*	528	*32.94*	481	*35.90*	183	*34.08*	1309	*35.25*
Motorcycle	**33**	***1.06***	**3193**	***25.10***	**2356**	***18.56***	**67**	***1.60***	**5649**	***17.27***	**5**	***0.31***	**575**	***12.22***	**201**	***3.78***	**5**	***0.12***	**786**	***5.02***
Motorcycle (collision)	0	*0.00*	974	*30.50*	571	*24.24*	24	*35.82*	1569	*27.77*	5	*100.00*	244	*42.43*	73	*36.32*	5	*100.00*	327	*41.60*
Motorcycle (non collision)	25	*75.76*	1032	*32.32*	861	*36.54*	32	*47.76*	1950	*34.52*	0	*0.00*	156	*27.13*	45	*22.39*	0	*0.00*	201	*25.57*
Motorcycle (unspecified)	8	*24.24*	1187	*37.18*	924	*39.22*	11	*16.42*	2130	*37.71*	0	*0.00*	175	*30.43*	83	*41.29*	0	*0.00*	258	*32.82*
Pedal cycle	**1952**	***62.64***	**2516**	***19.78***	**4837**	***38.11***	**2628**	***62.86***	**11,933**	***36.48***	**908**	***56.89***	**858**	***18.24***	**2174**	***40.90***	**2248**	***55.56***	**6188**	***39.51***
Pedal cycle (collision)	194	*9.94*	289	*11.49*	407	*8.41*	304	*11.57*	1194	*10.01*	99	*10.90*	184	*21.45*	223	*10.26*	222	*9.88*	728	*11.76*
Pedal cycle accident	1699	*87.04*	2173	*86.37*	4364	*90.22*	2283	*86.87*	10,519	*88.15*	786	*86.56*	654	*76.22*	1922	*88.41*	2001	*89.01*	5363	*86.67*
Pedal cycle (unspecified)	59	*3.02*	54	*2.15*	66	*1.36*	41	*1.56*	220	*1.84*	23	*2.53*	20	*2.33*	29	*1.33*	25	*1.11*	97	*1.57*
Pedestrian	**560**	***17.97***	**326**	***2.56***	**391**	***3.08***	**322**	***7.70***	**1599**	***4.89***	**277**	***17.36***	**234**	***4.97***	**305**	***5.74***	**609**	***15.05***	**1425**	***9.10***
Pedestrian (collision)	399	*71.25*	272	*83.44*	340	*86.96*	273	*84.78*	1284	*80.30*	206	*74.37*	196	*83.76*	263	*86.23*	476	*78.16*	1141	*80.07*
Pedestrian (unspecified)	161	*28.75*	54	*16.56*	51	*13.04*	49	*15.22*	315	*19.70*	71	*25.63*	38	*16.24*	42	*13.77*	133	*21.84*	284	*19.93*
Other	**256**	***8.22***	**2734**	***21.49***	**2175**	***17.14***	**555**	***13.27***	**5720**	***17.49***	**172**	***10.78***	**1435**	***30.50***	**1296**	***24.38***	**647**	***15.99***	**3550**	***22.66***
Other (collision)	74	*28.91*	384	*14.05*	285	*13.10*	78	*14.05*	821	*14.35*	48	*27.91*	213	*14.84*	156	*12.04*	64	*9.89*	481	*13.55*
Other (non collision)	0	*0.00*	67	*2.45*	39	*1.79*	5	*0.90*	111	*1.94*	0	*0.00*	16	*1.11*	5	*0.39*	0	*0.00*	21	*0.59*
Other (unspecified)	182	*71.09*	2283	*83.50*	1851	*85.10*	472	*85.05*	4788	*83.71*	124	*72.09*	1206	*84.04*	1135	*87.58*	583	*90.11*	3048	*85.86*
Total	3116	9.53%	12,723	38.90%	12,691	38.80%	4181	12.78%	32,711	*100.00*	1596	10.19%	4705	30.04%	5316	33.94%	4046	25.83%	15,663	*100.00*

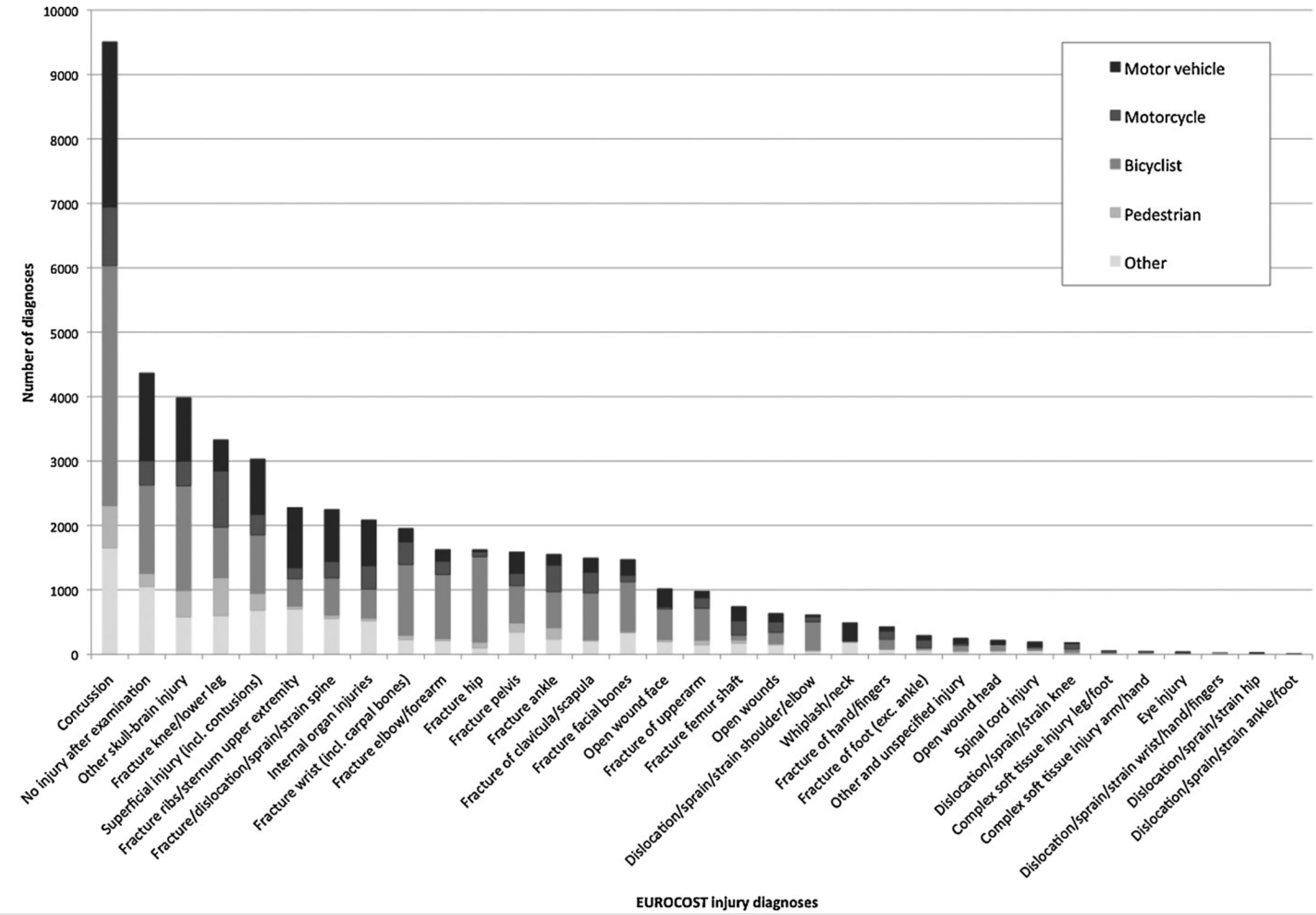

Fig. 1. Cumulative count of diagnosed injuries per road user category.

children and the >64 year olds have the highest number of inpatients.

3.2. Injuries after road traffic accident

The most frequent diagnosis was concussion (Fig. 1), ranking first in all road users. 'No injury after examination' and 'other skull–brain injury' ranked second and third, ranking high in all road users. 'Fracture knee/lower leg' and 'superficial injury' complete the top 5 most frequent diagnosed injuries, which sums up to more than half of all diagnosed injuries (50.06%).

Injury pattern distribution varied by road user (Chi^2 p-value over all road user categories <0.001). Head injury was the most predominant injury over all road users except for motorcyclists. The proportion of head injury decreases as age increased, but remained high in pedestrians. Injury to the spine and vertebrae was most prevalent in motor vehicles (10.1%). Injury to the abdomen/thorax constitutes a large proportion of the diagnosed injuries in motorcycles (29.8%) and bicyclists (28.8%). The lower extremities were the most injured body regions in motorcyclists (31.5%), pedestrians (35.2%), and older bicyclists (up to 38.8%).

An association of collision on injury pattern was identified in all road user categories. In motor vehicle occupants only minor differences were discovered, with the largest difference in spine/vertebrae injuries in collision accidents (12.8%) as opposed to non-collision accidents (10.0%). In motorcyclists, head injury (27.6%) and injury to the lower extremities (35.7%) were more frequent in collision accidents, while abdomen and thorax injury were more frequently observed in non-collision accidents (34.2%). In bicyclists a large difference exists, with head injury approaching almost half of all injuries (48.8%) in collision accidents, against 29.8% in non-collision accidents. In the latter thorax/abdomen injury became more prevalent (31.1%). For pedestrians a comparison was not possible as pedestrian falls (non collision accidents) were not included.

3.3. Burden of injury

A total of 182,378.59 DALY were calculated. DALY per 10,000 inhabitants were highest in the 'other' group (26.25 in males and 10.63 in females), followed by 'motor vehicle' (19.74 in males and 6.54 in females) (Table 2). YLL were responsible for most of the DALY in each category, except for motorcyclists, where the proportions were more or less equal, and bicyclists. In bicyclists, DALY were principally determined due to permanent disability. Comparing the YLD per road traffic victim by collision type (Fig. 2), vulnerable road users (i.e. motorcyclists and bicyclists) had a higher median disability in collision accidents, while occupants of motor vehicles showed a higher median disability in non-collision accidents. The median value for disability in occupants of motor vehicle, irrespective for collision type, was lower than in vulnerable road users.

When looking at the risk of DALY expressed by travelled kilometre (10^9), males had on average a higher risk (Table 2). Remarkable is that in our study this was not the case for bicyclists. As opposed to the high population rate of DALY, the effect of motor vehicles disappeared almost completely with 142 and 74 DALY for males and females respectively, or somewhat more than 1% of the total

Table 2
DALY: total, population rate and exposure rate per kilometre travelled.

	Males				Females			
	Temporary YLD	Permanent YLD	YLL	DALY	Temporary YLD	Permanent YLD	YLL	DALY
Total DALY (2003–2007)								
Motor vehicle	1030.28	10,082.74	24,282.67	35,395.69	452.82	3862.28	7617.97	11,933.07
Motorcycle	802.66	9841.60	10,700.19	21,344.46	99.74	1815.41	862.65	2777.79
Bicyclist	1613.29	12,910.63	5286.04	19,809.95	829.18	7388.95	2415.89	10,634.03
Pedestrian	227.91	3263.13	6597.18	10,088.21	201.68	2437.26	2805.25	5444.18
Other	764.58	7785.22	39,203.68	47,753.49	445.68	3833.75	12,918.29	17,197.72
Annual population rate (per 10,000 inhabitants)								
Motor vehicle	0.59	5.82	13.32	19.74	0.25	2.15	4.13	6.54
Motorcycle	0.46	5.68	6.13	12.27	0.06	1.01	1.03	2.09
Bicyclist	0.93	7.46	2.87	11.26	0.46	4.12	1.74	6.32
Pedestrian	0.13	1.88	3.43	5.44	0.11	1.36	0.98	2.45
Other	0.44	4.50	21.31	26.25	0.25	2.14	8.24	10.63

	Males					Females				
	Travelled km (10^9)	Temporary YLD	Permanent YLD	YLL	DALY	Travelled km (10^9)	Temporary YLD	Permanent YLD	YLL	DALY
Annual exposure rate (per 10^9 km)										
Motor vehicle	48.27	4.27	41.78	95.60	141.65	31.82	2.85	24.28	46.56	73.69
Motorcycle	0.63	253.66	3110.22	3353.47	6717.35	0.15	134.27	2443.97	2475.44	5053.67
Bicyclist	2.95	109.25	874.26	336.43	1319.94	1.53	108.35	965.55	406.85	1480.75
Pedestrian	0.77	59.09	846.09	1538.07	2443.25	0.80	50.20	606.65	438.27	1095.11
Other	5.57	27.44	279.40	1324.39	1631.22	5.74	15.53	133.59	514.88	664.00

amount of DALY per billion kilometres. Most prominent is the high number of DALY in motorcyclists (6717 and 5054 DALY), accounting for half of all DALY per kilometre. After motorcyclists, pedestrians constituted the second highest amount of DALY per kilometre travelled (1538 and 1095 DALY) with 16% of all DALY per kilometre, followed by bicyclist. Bicyclists accounted for 1320 and 1481 DALY for males and females respectively or 13% of all DALY per kilometre travelled.

Next to the major differences in road user category large differences in age were found (Fig. 3). Motorcyclists showed an extreme peak of 34,326.34 DALY in the age category 25–34, and had the highest risk in all the remaining age categories, except for the very young and old. Motor vehicles and the 'others' follow the same age pattern. In these groups the highest risk were found in the age category 15–24, from where the risk gradually decreases with age. For pedestrians and bicyclists an opposite pattern was observed, with a high risk for the younger and older age categories (0–24 and +55) although these differences were less pronounced.

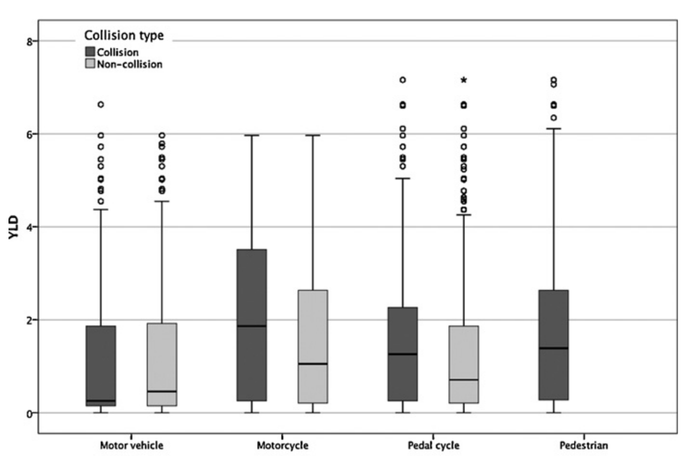

Fig. 2. Distribution of YLD per traffic victim in collision and non-collision accidents (the figure is truncated at 8 YLD, not showing 0.3% of the cases). Difference between collision types was significant for all road users (p-value < 0.001 – Mann–Whitney's U-test).

4. Discussion

In this study we estimated the health risk of RTAs, using Flemish and Brussels health data. Our attempt of examining both the injuries and the resulting burden across road users gives comprehensive results for road traffic safety policy in the area. Our findings concerning injury pattern mainly correspond with other studies in the field, such as the overall high proportion of head injuries, the high proportion of spine injuries in occupants of motor vehicles and the high proportion of lower extremities in motor cyclists and pedestrians (Ferrando et al., 1998; Markogiannakis et al., 2006; Bauer and Steiner, 2009). The link with disability and passenger kilometres travelled offers an added value to these results as DALY give a clear idea which injuries result in the largest health burden and are put into perspective of the actual exposure. Our results can therefore help in identifying the road users at elevated risk of bearing a large health burden. To date only few studies were able to derive a risk, with many of them using other exposure estimates, such as time travelled (Ferrando et al., 1998; Tin et al., 2010) or number of trips (Beck et al., 2007), or deriving their risk from other different injury groups, such as major trauma or minor accidents only (Aertsens et al., 2010; Holtslag et al., 2008).

Our results indicate that motor vehicles are the safest transport mode per travelled kilometre, with a health burden somewhat higher than 1% of the total health burden per kilometre travelled. However these motor vehicles represent a larger risk for other road users. It was clearly shown that disability is higher among vulnerable road users (i.e. those unprotected by an outside shield) in collision accidents. This higher disability is explained by the high proportion of head injury in bicyclists and lower extremity injury in motorcyclists in collision accidents. The high proportion of lower extremities in motorcycle accidents is a well-known fact and is shown to be due to direct impact from the colliding vehicle or entrapment between the colliding vehicle and the motorcycle (Harms, 1989; Peek et al., 1994). The high proportion of head injury in bicyclist collision accidents was also found in several studies (Bauer and Steiner, 2009; Van Kampen, 2008; Tin et al., 2010). In contrast, the higher proportion of injuries to the abdomen/thorax explains the lower disability in non-collision accidents in bicyclists. These injuries represent a smaller hazard to disability than for

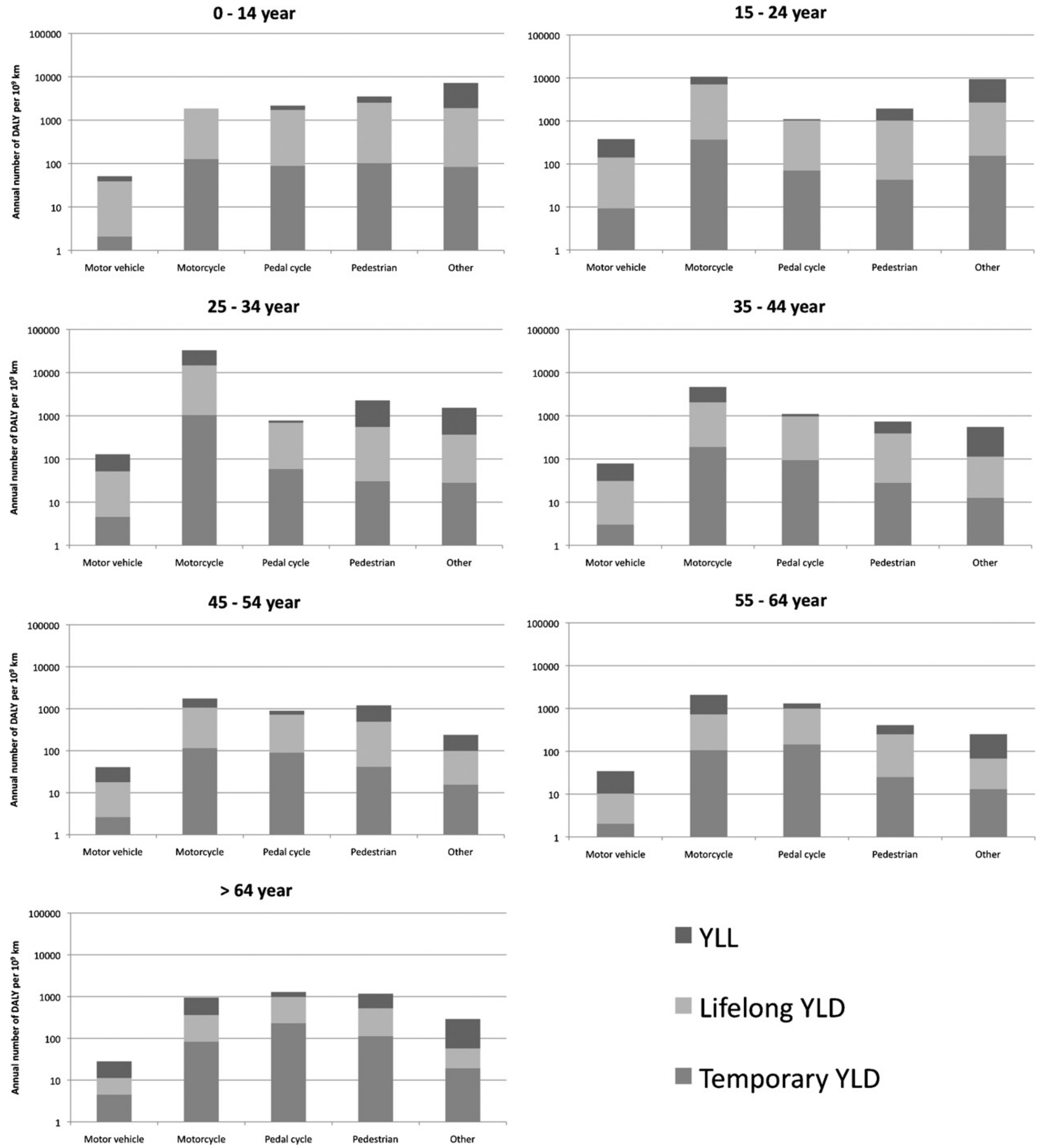

Fig. 3. Distribution of annual DALY (divided in YLL, lifelong YLD and temporary YLD) per 10^9 km for different age groups.

example injuries to the lower extremities (Polinder et al., 2007b). Recently the risk of a minor cycle RTA in Flanders and Brussels was found to be on average 1 per 20,000 kilometres cycled (de Geus et al., 2012). A minor accident was defined as an accident with an injury that did not require a hospital admission longer than 24 h. Here we found the risk of being admitted to the hospital to be 1 admission per 1,250,000 kilometres. Therefore, per 1,250,000 cycled kilometres 60 minor accidents occur and 1 has to be admitted to the hospital. Pedestrians had a high proportion of injury to the lower extremities, together with head injury, therefore also presenting a significant risk for both disabilities and death (Arregui-Dalmases et al., 2010).

When comparing our population rates with the few other studies, our results on the burden of the injuries in Belgium were somewhat less than in other countries. Most comparable are those from a comparative study of 6 European countries (Austria, Denmark, Ireland, the Netherlands, Norway and the United Kingdom) accounting both emergency and hospital admissions, and which reports between 20 and 50 DALY per 10,000 for men (our study on average 15.0 per 10,000) and between 5 and 15 DALY per 10,000 for women (5.6 per 10,000 in our study) (Polinder et al., 2007a). A French study, which also included both emergency and hospital admissions, reported to have 53.7 and 16.8 DALY per 10,000 for men and women respectively (Lapostolle et al., 2009). A study from a Dutch cohort of major trauma patients reported an average 39 DALY per 10,000 inhabitants for RTAs (Holtslag et al., 2008). It is important to take into account that the methods used to calculate the DALY are different (different sets of disability

weights and data selection) and that these methodological aspects may have a large impact on the number of DALY. However when comparing the exposure-based rates we found our results to be in line with those reported elsewhere. The Dutch cohort of major trauma patients reported 5120 and 1276 DALY respectively for motorcyclists and pedestrians, which both match our results. For bicyclists (758 DALY) our risks were higher, which may also be partially explained by the even higher popularity of cycling in the Netherlands. For motor vehicle (216 DALY) we found lower values.

There are some limitations to the data. The usefulness of health data to researchers is affected by the quality of coding, more particularly the high level of unspecific codes (Lawrence et al., 2007). Regarding the mortality data it has been suggested that the inaccuracies of coding could be greater for mortality records compared to hospital discharge records (Johansson and Westerling, 2002; Tin et al., 2010). In our data we also noticed a larger proportion of "unspecified" in the mortality statistics than in the MCD, which could partially explain why the 'other' group has a fairly large proportion of DALY, which should normally be attributed to one of the four other categories. When using MCD it is also important to recognize that not all injury diagnoses have an external code. The doctor who first sees the patient documents the external causes, based on the anamnesis of the patient or his/her relatives, or in some cases by the police report. Consequently, the information on accident circumstances (e.g. vehicle type and accident type) may be less reliable than in police records. Additionally, injuries may not be coded as caused by a traffic crash. This represents a special case of underreporting, as there is no direct information on the proportion of injuries being missed or misclassified. Because of privacy restrictions the researchers did not have direct access to the complete injury dataset to verify the codings and strata with less than 5 counts could not be reported. We also only gathered injury information from the main diagnosis. As in other studies (Polinder et al., 2005), we have to acknowledge that this can pose difficulties, in terms of selecting diagnoses based on resource use, rather than clinical severity. We therefore conclude that the numbers in this paper are conservative estimates.

Despite the limitations and a rather conservative estimation, these results may be of great value for road safety policy as they serve to better understand the health burden of RTAs. As it was shown that YLD add to a very large degree to the health burden of RTAs, using medical data for road traffic injury research can help to emphasize the health problem that RTAs cause. A next step could be to link medical and police data. Linking both datasets can provide information on both the circumstances of the accident, as well as on the injury consequences following the accident. Also underreporting coefficients can be derived to estimate the 'real number' of seriously injured traffic victims (Broughton et al., 2010). However to do so, a more extensive medical dataset would be needed, with a more elaborate selection of E-codes. It has been shown in the Netherlands that around 9% of traffic accidents are coded with an E-code not related to road traffic accidents (Reurings and Bos, 2011). Additionally, variables such as time and date of admission to the hospital are not or only partly registered in medical datasets, which poses difficulties to create a key to link one file to another. Future efforts trying to link both datasets should therefore look for other ways to identify common records in both medical and police datasets. But in absence of such a key, the medical data is preferred to estimate the health burden of traffic accidents.

In a preliminary effort to compare our results with the total numbers registered by police, we found a rather low degree of registration by the police, especially in motorcycle, pedestrian and bicyclist accidents (respectively 53, 52 and 18% were registered by the police, compared to 83% for motor vehicles). Mainly a large proportion of bicycle accidents seem to be unregistered in the police data. This may be explained by the fact that most bicycle accidents are non-collision accidents and that registration depends on the type of road user (motorized vs. non-motorized), third party involvement, age of victim and severity of injury (Amoros et al., 2006). It is clear that police data is not reliable for those victims needing medical treatment in the hospital. Our findings may therefore be an incentive for policy to rely more on medical data and to promote an accurate and reliable reporting of traffic accidents in both medical and police registers.

5. Conclusion

This study combined several datasets to estimate the health risk of RTAs in Flanders and Brussels. The risk per kilometre travelled was highest for vulnerable road users, primarily motorcyclists, followed by pedestrians and bicyclists. In these groups the health burden was to a large extent attributable to injuries. Specific attention is required for motorcyclists. They not only have one of the severest disabilities after an RTA, this high disability is also translated into a very high disability risk per travelled kilometre, stressing the high vulnerability of these road user categories. In official statistics, based on police records, the groups with the highest health burden per kilometre are greatly underestimated. A road traffic safety policy that is solely supported by police statistics, not only runs the risk of being incomplete, but also lacks essential data about the accident consequences and provides a false platform of information for resources and planning. Planning appropriate policies to address road safety requires valid data and medical data could provide that essential and hitherto missing data. The MCD is a valuable addition for accidents requiring hospital admission and could evolve in an accurate policy instrument in Belgium, especially for those accidents that are missed by the police scope. Moreover, when combined with information on injury consequences they could aid in identifying road traffic safety bottlenecks and help in a more effective allocation of resources and priorities.

Competing interests

The authors declare that they have no competing interests.

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